



NATIONAL INITIATIVE FOR CYBERSECURITY EDUCATION

A HISTORICAL REVIEW OF HOW OCCUPATIONS BECOME PROFESSIONS

Whitepaper

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1 Purpose of this Paper

As the lead for the National Initiative for Cybersecurity Education (NICE) Component 3 - Cybersecurity Workforce Structure, the Department of Homeland Security (DHS) is exploring the professionalization of cybersecurity. Cybersecurity professionalization is a complex process that affects multiple public and private sector stakeholders.

The purpose of this paper is to provide an overview of how four occupations have been professionalized so that DHS and Component 3 stakeholders can gauge the federal government's level of involvement necessary to professionalize the cybersecurity field. This paper serves as a starting point to identify the current state of occupations in the cybersecurity field so that the best practices can be employed if professionalization of the cybersecurity field is deemed necessary or desirable.

Professionalization is defined and expressed as three models. This is followed by brief highlights of four occupations from their origins as occupations with few standards to their current status as professionals. Three academic models through which an occupation becomes a profession are identified. Finally, a summary of the professionals within the medical field is presented.

2 Defining a Profession

For the purposes of this paper, the operational definition of profession is "a profession is defined by: (1) a body of knowledge, (2) ethical guidelines, and (3) a professional organization with a growing set of published papers and best practices" (Cox, 2010, p. 7). Professionalization is characterized as, "when a profession arises when any trade or occupation transforms itself through the development of formal qualification based upon education, apprenticeship, and examinations, the emergence of regulatory bodies with powers to admit and discipline members, and some degree of monopoly rights" (Bullock and Trombley, 1999).

3 Professionalization Models

Theoretical work in the sociological literature suggests three categories of professionalization models, each of which offers a different perspective on the development of a given profession: attribute models, process models, and power models. Each profession evolves differently; therefore, one model is not necessarily better than the others. The maturity of the profession determines which model is the most appropriate for use by an organization. For example, when the community or an organization decides to professionalize an occupation, the process model would be most appropriate to begin the initial stage of professionalization. However, if an organization needs to determine the skills necessary for an occupation, the attribute model would be more appropriate. Lastly, the power model exemplifies an organization restricting the supply of certain services from one group with lesser qualifications, and transfers this service to another group with appropriate skills and training (Curnow and McGonigle, 2006, p. 287). These three models are described below.

3.1 Attribute Model

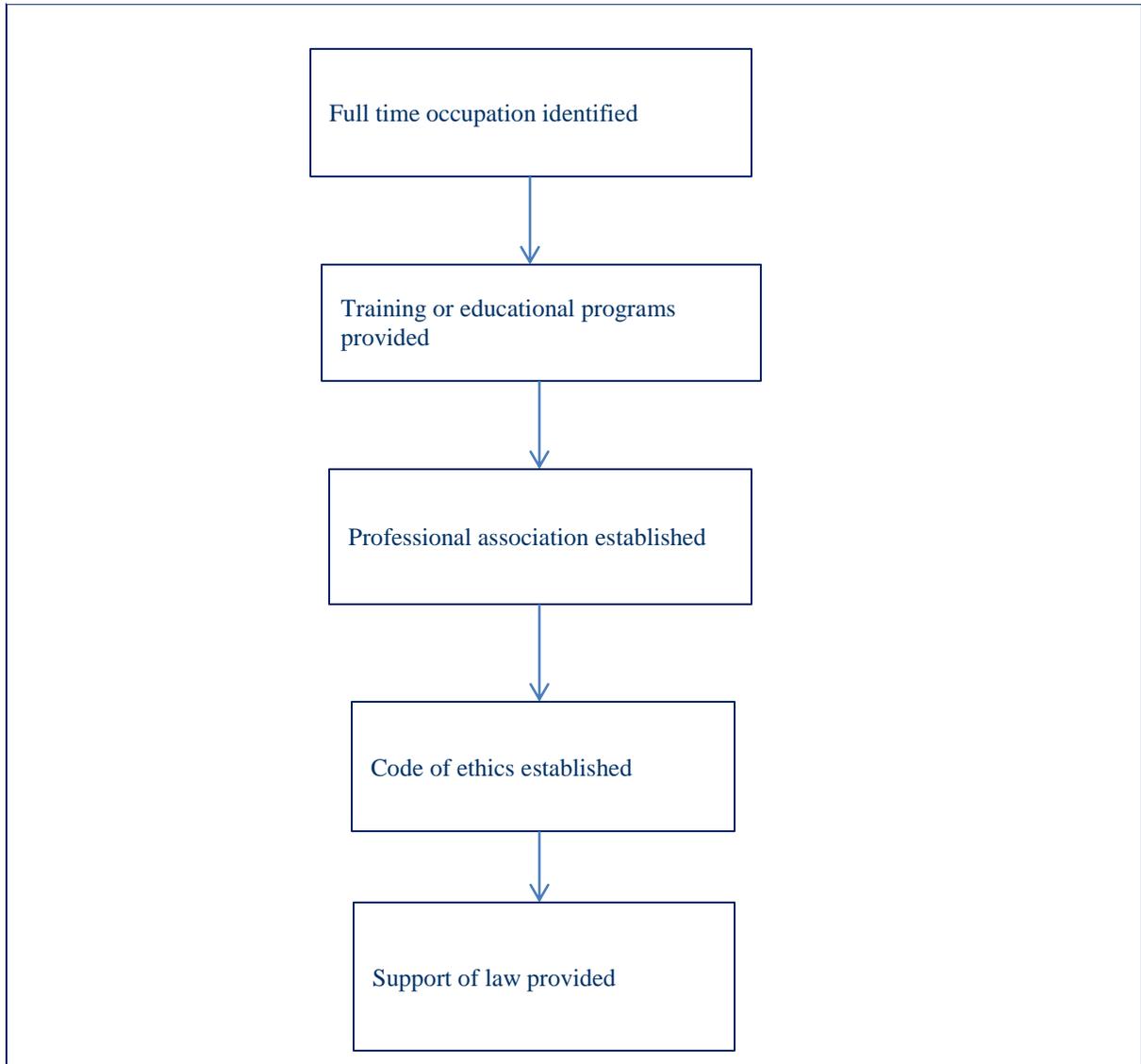
The attribute model describes the traits, attributes or characteristics that define a profession as something different than other occupations. When using this model, criteria are developed first to define the standards of the profession however, an occupation is not considered a profession until all of the criteria are met, and the profession in question provides a service that is for the public good (Curnow and McGonigle, 2006, p. 287).

3.2 Process Model

In contrast to the attribute model, the process model describes the sequence of events for professionalization. It follows a five-stage process in which each stage has a direct effect on the previous stage. The initial stage of the process model occurs when the full-time occupation is identified. At this point, the community of those involved in the occupation determines a need for this occupation. In the second stage, training or educational programs are established. In this stage, the knowledge and skills are identified and incorporated into a training or educational curriculum. In the third stage, a professional association is established to help define the profession. Qualifications such as certifications and licenses are developed in order to help differentiate the services of one occupation from another, as well as to distinguish qualified from unqualified practitioners. In the fourth stage, the code of ethics is developed. Professional associations define the standards of its profession, the codes of practice, the entry requirements and the disciplinary procedures that govern it. A professional association recognizes accepted methodologies and recognizes professionals who follow these methodologies (McConnell, 2004). The final stage involves gaining the support of law. The profession engages in political action such as lobbying for legal protection, legal restrictions, and recognition of title and work activities (Curnow and McGonigle, 2006, p. 288).

Figure 1 represents a process model of professionalization presented by Curnow and McGonigle (2006), which is based on similar models by Wilensky (1964), Houle (1981), Snider (1996), Tobias (2003), and Vollmer and Mills (1966). This model illustrates the professionalization process chronologically; however, it should be noted that events in one stage might influence the previous stage.

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Figure 1 Process Model



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3.3 Power Model

The third professionalization model is the power model, also known as the market model. Power models focus on the motivations for professionalization and how these motivations emerge. For example, do stakeholders seek professionalization in order to improve the quality of services provided, to establish a monopoly over these services, or both? Many view the regulation of entry by professional associations and local and state governments as a motivation by a profession's interest in "creating a monopoly situation to limit competition and raise prices (Law Kim, 2004, p. 3)." Therefore, it is important for a profession to demonstrate that regulation of entry into the profession improves the quality of services that consumers expect to receive, even if it increases the wages of professionals or limits competition.

3.4 Elements of a Mature Profession

Table 1 lists the elements of a mature profession identified by McConnell (2004). McConnell states that a profession's maturity can be gauged to the extent that it has formalized each of the elements included in the table below. The more elements applicable to a profession, the more mature the profession. As will be seen in Section 4.5, an element attributed to a profession can be independent of another element. In other words, a profession may have an "Initial Professional Education" but not a "Licensing" element.

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Table 1 Elements of Professional Maturity

Element	Description
Initial Professional Education	Advanced university programs for a particular field, such as law school for lawyers and medical school for doctors.
Accreditation	Such advanced university programs must be accredited by one or more oversight bodies.
Skills Development	Required period of actual practice in applying university knowledge before a certification exam can be taken. For example, accounting professionals must work for one year for a board-approved organization before taking the Certified Public Accountant (CPA) exam.
Certification	An actual exam, such as the CPA exam for accountants.
Licensing	Mandatory and administered by a governmental authority.
Professional Development	Ongoing professional education, most critically in a profession, such as medical doctors, with a rapidly changing body of knowledge.
Professional Societies	Group of like-minded individuals who put their professional standards above their individual self-interest or their employer's self-interest.
Code of Ethics	Imposition of a behavioral standard against which to eject professionals from their professional societies or cause them to lose their licenses to practice for violating the code.

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4 Occupations

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The models above describe the process through which professional skills are identified, developed, and maintained. Below are descriptions of occupations and how they became a profession. Air traffic controllers and firefighters are included because these occupations are critical for public safety in life-or-death situations. Contract Specialists are included because it is one of the most recent occupations that have been dramatically affected by government initiatives and in its final stages of professionalization. Lastly, physicians are included because it is the most seasoned profession of the four.

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4.1 Air Traffic Controller

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The initial process of the federal government professionalizing the field of air traffic control began as early as 1926. After the passage of the Air Commerce Act, it authorized the Department of Commerce to establish and enforce air traffic rules for the navigation, protection, and identification of aircraft (Centinneapolisflight.gov). It also included the enforcement of licensing pilots, certifying aircraft, and operating funding for air navigation. Slowly the federal government began taking over the operation of local control towers during the 1940s, and post-

1 World War II, all aspects of air traffic control became a part of the federal government (Poole
2 Edwards, 2010, paragraph 1).

3
4 It was recognized that air traffic controllers were needed about two decades after the introduction
5 of powered flight. Aviation programs began forming across the country, and the Federal
6 Aviation Administration (FAA) formed partnerships with many colleges and universities. These
7 schools offer two- and four-year non-engineering aviation degrees that teach the basic courses in
8 air traffic control. This program is recognized as the Air Traffic Collegiate Training Initiative
9 (AT-CTI), and is designed to provide qualified applicants to fill the developmental air traffic
10 control specialist positions. Graduates of the AT-CTI program are eligible to bypass the Air
11 Traffic Basics Course, which is the first five weeks of qualification training at the FAA Academy
12 in Oklahoma City (FAA, n.d, paragraph 1).

13
14 However, all AT-CTI graduates are not guaranteed employment with the FAA. AT-CTI
15 graduates must complete the following:

- 16
- 17 • Receive an official school recommendation
- 18 • Be a United States citizen
- 19 • Pass a medical examination
- 20 • Pass a security investigation
- 21 • Achieve a score of at least 70 on the FAA pre-employment test
- 22 • Speak English clearly enough for others to understand on communications equipment
- 23 • An interview

24 (FAA, n.d, paragraph 1)

25
26 Those that do not attend an FAA approved AT-CTI program, have two additional pathways to
27 become an air traffic controller: (Bureau of Labor Statistics, 2011).

- 28
- 29 • Prior experience through either FAA or the Department of Defense as a civilian or
30 veteran.
- 31 • Applicants from the general public must have a minimum of three years of full-time work
32 experience, have completed a full four years of college, or a combination of both.

33
34 Upon meeting the above criteria, employees attend the FAA Academy for 12 weeks, during
35 which they learn the fundamentals of the airway system, FAA regulations, controller
36 equipment, and aircraft performance characteristics, as well as specialized tasks. After
37 graduation, candidates are assigned to an air traffic control facility and are classified as
38 “developmental controllers” until they complete all requirements to be certified for all of the
39 traffic control positions within a defined area of a given facility (Bureau of Labor Statistics,
40 2011).

4.2 Firefighter

When initially established, fire companies (as once referred) were a highly unorganized guild. There was no order in determining which fire company was assigned to an emergency. Instead, insurance companies created competition within the field by establishing a bonus system and rewarded the first fire company that could put the fire out. Fire marks affixed to policyholders' homes and buildings were used by insurance companies in determining which fire company to apply payment (McChesney, 1986, p. 71).

The trend of providing fire services to the city in exchange for monetary bonuses began to spread rapidly, and so did the personal character of the volunteer clubs. No longer were the honest and hardworking firefighters filling the jobs in the fire clubs. Instead, fire clubs included men with little else to do but use the firehouse as the local "hangout." There were no requirements for entry into the fire club. Fire clubs began recruiting professional boxers and common thugs to battle other companies in order to be the first on the scene and win the bonuses. This resulted in an increase of violence that spread across several areas. By 1853, the Cincinnati government interceded by disbanding the volunteer fire companies and began its efforts to establish America's first paid fire department (McChesney, 1986, p. 77).

Entry requirements for the firefighter profession were established by the International Association of Firefighters (IAFF). Most departments have basic requirements such as being a U.S. citizen, having a valid driver's license, and a high school diploma or GED. However, having a college degree increases a firefighter's chances of obtaining employment. Age requirements vary by state and municipality, but generally firefighters must be between the ages of 18 and 35 (BLS, 2011).

Most entry-level workers in large fire departments are trained for several weeks at the department's training center or academy. The U.S. Fire Administration, an entity of the Department of Homeland Security, includes the National Fire Academy. Classroom instruction and practical training includes studying firefighting techniques, fire prevention, hazardous materials control, local building codes, and emergency medical procedures. After completing training, recruits are assigned to a fire company and undergo a period of probation (BLS, 2011).

Almost all fire departments require firefighters to be certified as an emergency medical technician (EMT). Individual states set their own standards of certification, however, all EMT training must meet the minimum requirements set forth by the National Highway Traffic Safety Administration (NHTSA), which recognizes the following three levels:

- EMT – B (Basic)
- EMT – I (Intermediate)
- EMT – P (Paramedic)

At a minimum, the EMT-B is required of all firefighters, however, many state and municipalities are requiring firefighters to be certified up to EMT – P (BLS, 2011).

1 In addition, many fire departments have adopted the Candidate Physical Ability Test (CPAT)
2 test. Developed by the IAFF, the CPAT is a practical exam that tests the candidate's physical
3 and mental abilities to perform tasks related to firefighting. The CPAT is a timed pass/fail test
4 that consists of eight events:

- 5 • Stair Climb
- 6 • Hose Drag
- 7 • Equipment Carry
- 8 • Ladder Raise and Extension
- 9 • Forcible Entry
- 10 • Search
- 11 • Rescue
- 12 • Ceiling Breach and Pull

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14 CPAT certifications are offered in all states. Historically, those municipalities that do not use
15 CPAT normally conduct physical ability tests instead (IAFF, n.d., paragraph 18).

17 **4.3 Contract Specialist**

18 A federal contract specialist, for the purpose of this paper, is one that works for the federal
19 government. The contract specialist is responsible for the negotiation and acquisition of goods
20 and services for the Government from commercial or noncommercial sources in accordance with
21 applicable Federal laws and regulations (Office of Personnel Management, n.d.). The
22 professionalization effort started as a result of Michigan Senator Carl Levin believing that the
23 root cause to many of the performance shortfalls in the defense acquisition system was the
24 failure of the Department of Defense (DoD) to maintain an acquisition workforce with the
25 resources and skills needed to manage the department's acquisition system (Schmitt &
26 Thompson, 2007, October 15). This resulted in government reform initiatives such as the
27 Government Performance and Results Act (GPRA) and the President's Management Agenda
28 (PMA) holding federal agencies more accountable for how they spend money. This also led the
29 federal government to making large investments in professionalizing the procurement workforce
30 (Curnow McGonigle, 2006).

31
32 The federal government was instrumental in establishing and defining an education and training
33 curricula for contract specialists. After Congress passed both the Defense Acquisition
34 Workforce Improvement Act (DAWIA) and Clinger-Cohen Acts, government agencies
35 responded by collaborating with each other to identify the three most critical functions required
36 to perform the work of a contract specialist. This included:

- 37 • Pre-solicitation work which involves conducting market research to identify potential
38 sources of products and services and selecting from the myriad of options for soliciting
39 them.
- 40 • Pre-contract work involves developing contract specifications, selecting sources, and
41 negotiating on behalf of the government.

- Post-contract work involves evaluating contractor performance and performing the administrative work necessary to support contractors or grantees (Curnow McGonigle, 2006).

Once the critical functions and related skills were identified, the government established several programs to ensure contract specialists had the necessary skills in these critical areas. One such program is the Defense Acquisition University (DAU), which was established under the DAWIA (Rendon, n.d, paragraph 7). The DAU developed curricula for each acquisition career field, to include descriptions of the education, experience, and core training required to meet the standards for certification. DoD, as well as other federal programs provided transportable certifications which are now currently recognized across all government agencies (Curnow and McGonigle, 2006).

4.4 Physician

During the early nineteenth century, the medical field's major concern was that the profession was overcrowded with unqualified medical practitioners. This created competition between the "qualified" and the "unqualified," and lead to denying those who were truly qualified to practice. As a result, qualified practitioners began complaining of bodily harm being done to patients. These problems lead to widespread demands within the medical profession to establish a system of registration and minimum training requirements to gain entry into the profession. In England, a lengthy campaign of demands by "qualified" practitioners lead to the establishment of the Medical Act of 1858 (Waddington, 1990).

This laid the foundation for establishing the General Medical Council, which consisted primarily of doctors, the responsibility to regulate the medical profession on behalf of the state government, oversight of the medical education, and to maintain the register of qualified practitioners (Waddington, 1990).

The movement to ensure only qualified practitioners enter the medical field spread to the United States where a group of doctors founded the American Medical Association (AMA) in 1847. Its purpose is to advance scientific disciplines, define and improve the standards in medical education, establish a code of medical ethics, and improve the public's health (AMA, 2001, paragraph 2).

4.5 Comparison of Profession Maturity

Table 2 compares the maturity elements of the four professional occupations discussed above. Varying levels of initial education, skill development, and ongoing accreditation is required for each profession. Over time each of the professions has been influenced by outside organizations, its own professional societies and varying levels of governments to develop proficiency in existing skills, develop new skills, meet new social and performance standards.

The only common theme in the drive to professionalization among the four occupations is the improvement toward a social need. Three of the four professions deal with the safety of human life whereas contract specialists improve the performance of government.

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Table 2 Professional Maturity of four Professions

Element	Air Traffic Controller	Firefighter	Contract Specialist	Physician
Initial Professional Education	X			X
Accreditation				X
Skills Development	X	X	X	X
Certification		X	X	X
Licensing				X
Professional Development	X	X	X	X
Professional Societies	X	X	X	X
Code of Ethics	X	X	X	X

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5 Professionals in the Medical Field

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In an effort to clarify the potential benefits and drawbacks of the federal government leading cybersecurity professionalization, this paper conducts a partial overview of the medical field, which is organized into a format analogous to the NICE cybersecurity framework. Members of the cyber community should gain a new perspective about how the cybersecurity field can be professionalized by a brief overview of occupations in the medical field.

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Similar to the cybersecurity field, the medical field offers a large number and wide variety of jobs in which individuals can pursue careers. Medical jobs may vary from a Medical Assistant responsible for maintaining medical records, billing, and coding information, to a physician or surgeon, whose patients face life or death situations.

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Like cybersecurity, each job category of the medical field can be broken down further into specialty areas. Each specialty area describes a unique role and set of knowledge and skills that are required to perform this role. As with most fields, some responsibilities, knowledge and skills might be the same for multiple roles. Nonetheless, each specialty area indicates unique responsibilities and knowledge requirements that differentiate one specialty area from another.

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Table 3 illustrates how the medical field contains a broad range of specializations, each with its own professional standards and requirements. The table is divided into “core” and “medical-related” professions. The “core” medical fields are those professions that are traditionally associated with direct patient care and have detailed and standardized education and licensure requirements. The “medical-related” fields are those professions that typically support or supplement core medical fields. They also have varying levels of formal education and licensure

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1 requirements. For example, job experience, rather than a degree or a certification, might qualify
2 someone to become a medical supply technician. However, fields such as a registered nurse and
3 pharmacist would require an undergraduate degree and license to practice.

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5 In contrast to cybersecurity, the medical field has made great progress in developing generally
6 agreed upon roles and articulating the education and licensing requirements for each role.

7 Defining roles and knowledge requirements helps medical workers within the various specialty
8 areas gain recognition and acceptance, and it helps ensure that medical workers meet sufficient
9 and consistent knowledge requirements.

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11 The medical field's diversity offers a potential template for stakeholders wishing to explore
12 cybersecurity professionalization. Although Table 3 offers a limited picture of the medical field,
13 it illustrates how various types of jobs can have varying levels of professionalization for specific
14 jobs.

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Table 3 Medical Occupation Chart

Qualifications	Education Requirements						Licensing/Certification Requirements		
	Associates Degree	Vocational School	Bachelor Degree	Masters Degree	Ph.D.	Medical School	National Board Exam	Certification	License
Core Medical Fields									
Registered Nurse (RN)	X		X	X					X
Physician			X						X
Pharmacist			X	X	X				X
Veterinarian			X				X		X
Medical-Related Fields									
Physical Therapist			X	X			X		
Ultrasound Technician (Sonographer)	X	X							
Medical Supply Technician	X	X							
Emergency Medical Technician (EMT)/Paramedic	X	X					X		X

SOURCE: American Medical Association (AMA) – Health Careers Directory
 O*Net OnLine – Department of Labor, Bureau of Labor Statistics

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6 Conclusion

The purpose of this paper is to provide an overview of how various occupations have been professionalized so that DHS and Component 3 stakeholders can gauge the federal government's level of involvement if any occupations in the cybersecurity field should be professionalized.

Descriptions of how occupations have been professionalized show common professional elements, such as a core body of knowledge needs to be identified and professional associations are needed to set training, education, and ethical guidelines; however, the path toward establishing these elements has varied for each occupation.

Furthermore, different levels of professional maturity can exist, and provide organizations a framework for determining its next steps. As demonstrated in this review, the federal government's role in the professionalization process varied from minimally involved (e.g., physicians) to extremely involved (e.g., contracts specialists). The professionalization process unfolds over years or decades rather than over short time periods, and professionalization involves governments, academic institutions, and private sector organizations are involved in the professionalization process. These stakeholders will be instrumental in professionalizing the field of cybersecurity in the coming years and decades.

Thus, is cybersecurity ready to be professionalized across the Nation? If so, how do members of the cyber community determine how much professionalization is needed? Should the federal government lead this effort single handedly? Overall, the effort to professionalize cybersecurity will not be a linear process due to the constant change of technology.

Acronym	Definition	Page#	Line#
DHS	Department of Homeland Security	1	3
NICE	National Initiative for Cybersecurity Education	1	2
CPA	Certified Public Accountant	5	9
FAA	Federal Aviation Administration	6	6
AT-CTI	Air Traffic Collegiate Initiative	6	9
IAFF	International Association of Firefighters	7	20
GED	General Education Diploma	7	21
BLS	Bureau of Labor Statistics	7	24
EMT	Emergency Medical Technician	7	34
NHTSA	National Highway Traffic Safety Administration	7	36
EMT-B	Emergency Management Technician - Basic	7	37
EMT-I	Emergency Management Technician-Intermediate	7	38
EMT-P	Emergency Management Technician-Paramedic	7	39
CPAT	Candidate Physical Ability Test	8	1
DoD	Department of Defense	8	24
GPRA	Government Performance Results Act of 1993	8	27
PMA	President's Management Agenda	8	28
DAWIA	Defense Acquisition Workforce Improvement Act	8	34
DAU	Defense Acquisition University	9	6
AMA	American Medical Association	9	28
RN	Registered Nurse	12	3

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